Space Weather Technical Forecast

Issued on Tuesday 26 November 2024 at 13:06 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Moderate to High Solar Activity expected with M-flares likely. G1/G2 Minor/Moderate Geomagnetic Storm expected 28 Nov.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with a number of M-class flares observed in the past 24-hours, peaking with an M2.0 flare at 25/1212 UTC from AR3906 in the southeast.

There are currently ten sunspot regions on the visible disc, with the spot on the NE limb recently numbered AR3910. AR3905 and AR3906 remain the largest spot regions, both containing a small delta configuration. Both these regions have seen intermediate spots decaying slightly. AR3907 in the southwest has seen its trailing spots consolidating into a larger region of mixed polarity, indicating a small delta configuration has formed. AR3910 rotating over the NE limb is still a way from becoming completely visible, but was responsible for an M9.4 flare on 25 Nov as it rounded the limb.

There was one likely Earth-directed CME during the period. A filament eruption starting around 25/2030 UTC close to AR3901 led to an M1.9 flare, marked coronal dimming and associated CME. Analysis has an Earth impact during the UTC morning of 28 Nov, but this timing may be tweaked with further analysis ongoing.

Solar Wind / Geomagnetic Activity: Solar winds as measured by ACE at L1 varied between Background and Slightly Elevated levels, due to minor fast-wind influence from CH94/- in the southwest disc, but this slowly declined to Background during the period, currently around 550km/s. The Interplanetary Magnetic Field, Bt, was Weak throughout, peaking at 7nT. The north-south component, Bz, varied weakly between +6/-7nT, with frequent deviations between positive and negative Bz observed. Phi angle was mainly negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 remained at Background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at Background levels. The associated 24-hour fluence remained well below the Active threshold. The integrated flux observed at 26/0000 UTC was 1.12e6.

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Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Moderate to High with occasional M-flares likely and a slight chance of isolated X-class flares occurring, primarily from AR3905, AR3906 or AR3910.

Solar Wind / Geomagnetic Activity: A CME that left the Sun late on 25 Nov from the southwest disc is likely to affect Earth on Day 3 (28 Nov).

Solar wind speeds are currently at Background levels and are expected to remain there at first. A rise to Elevated levels is possible following the CME arrival on Day 3.

Geomagnetic activity is expected to be mainly Quiet to Unsettled (Kp0-3) at first. Upon arrival of the CME on Day 3 (28 Nov), G1/G2 Minor/Moderate Geomagnetic Storms are expected, with a slight chance of G3/Major Geomagnetic Storm intervals. Enhanced conditions are likely to persist into Day 4 (29 Nov).

Energetic Particles / Solar Radiation: High energy protons are expected to persist at Background levels, with a slight but increasing chance of Solar Radiation storms occurring later in the period, mainly from the large sunspot regions in the southeast. High energy electron flux has been at Background levels and is expected to persist at these levels throughout. The associated 24 hour fluence is expected to persist below the Active threshold.

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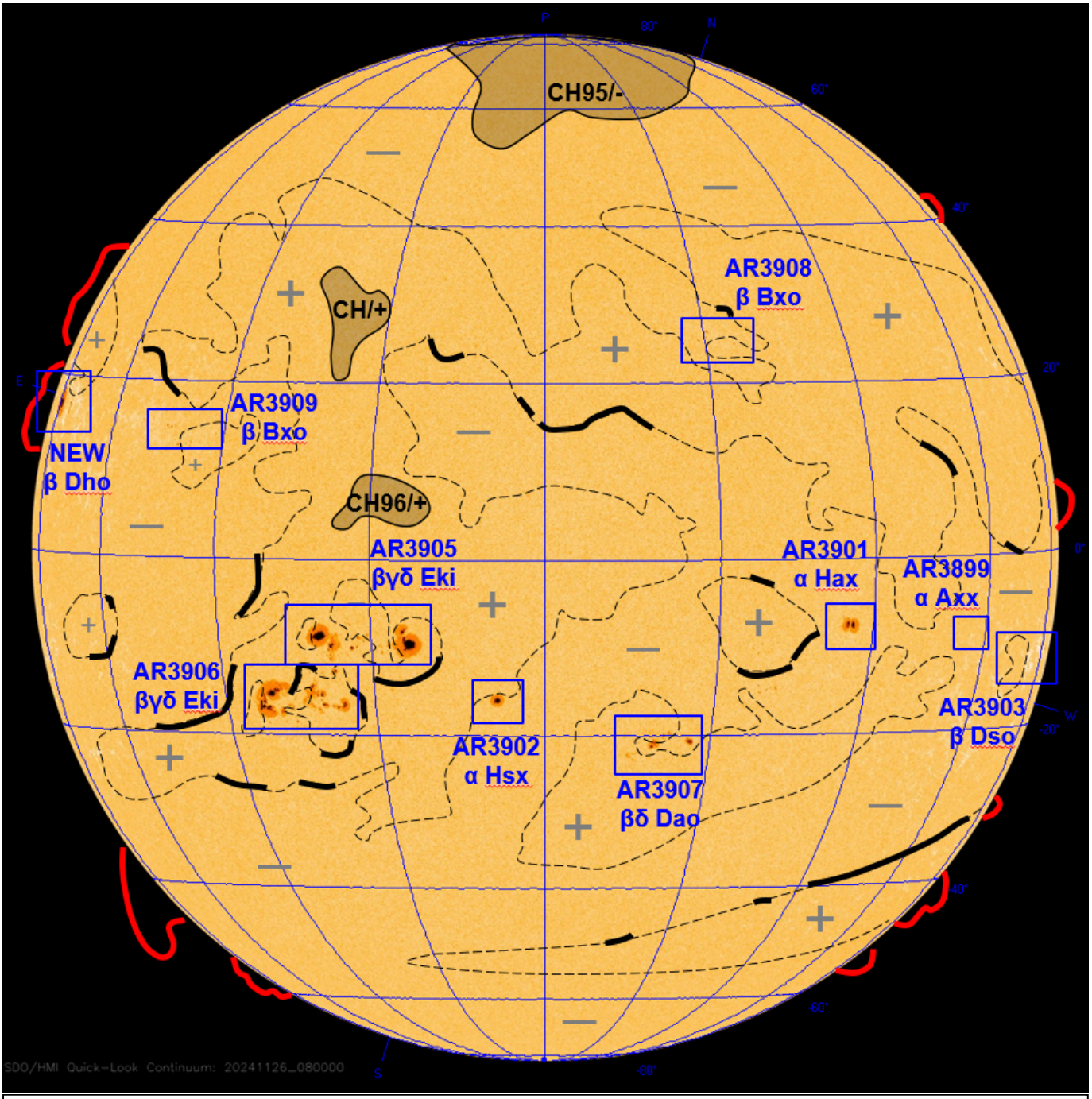
Figure 1: Solar Synoptic Map valid 26/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

Numerous CMEs have left the Sun in recent days, reducing confidence in the analysis of individual events, however, there are considered to be three events of note with potential Earth-directed effects. The first two CMEs left the Sun in quick succession early on 25 Nov from the southeast disc. The first of these has been attributed to the M1.1 flare of AR3906 at 25/0159 UTC, followed by a large filament eruption around 25/0230 UTC. Initial modelling suggests that the bulk, if not all of the ejecta is directed south and east of the Earth-Sun line, however, some slight Earth-directed component and glancing impact from these slow CMEs cannot completely be ruled out to arrive on Day 4 (29 Nov). Perhaps more significantly, a filament eruption starting around 25/2030 UTC close to AR3901 led to an M1.9 flare and marked coronal dimming, along with a Type II Radio Emission (estimated velocity 490km/s). The bulk of the ejecta from this CME appears to be directed to the southeast, but there is a more halo-like shock visible in imagery. Analysis of this CME suggests an arrival time during the UTC morning of 28 Nov.

Solar winds are now at Background levels following a waning connection to CH94/-, located near the southwest limb. Solar winds are expected to remain at Background over the next couple of days, likely increasing upon arrival of the forecast CME on 28 Nov, perhaps to Elevated levels. No other coronal hole fast wind enhancements are expected through this period. MOSWOC Enlil model output continues to significantly over estimate solar wind speeds, and is considered likely to be too fast until Day 3 (28 Nov).

Geomagnetic activity is expected to be mainly Quiet to Unsettled (Kp0-3) at first. Upon arrival of the CME on Day 3 (28 Nov), G1/G2 Minor/Moderate Geomagnetic Storms are expected, with a slight chance of G3/Major Geomagnetic Storm intervals. Enhanced conditions are likely to persist into Day 4 (29 Nov).

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	10	80	60
Strong	G3	No	1	1	20	10
Severe	G4	No	1	1	5	1
Extreme	G5	No	1	1	1	1

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Figure 2: MOSWOC Enlil model. Note that current wind speeds are being overplayed in the model compared to reality.

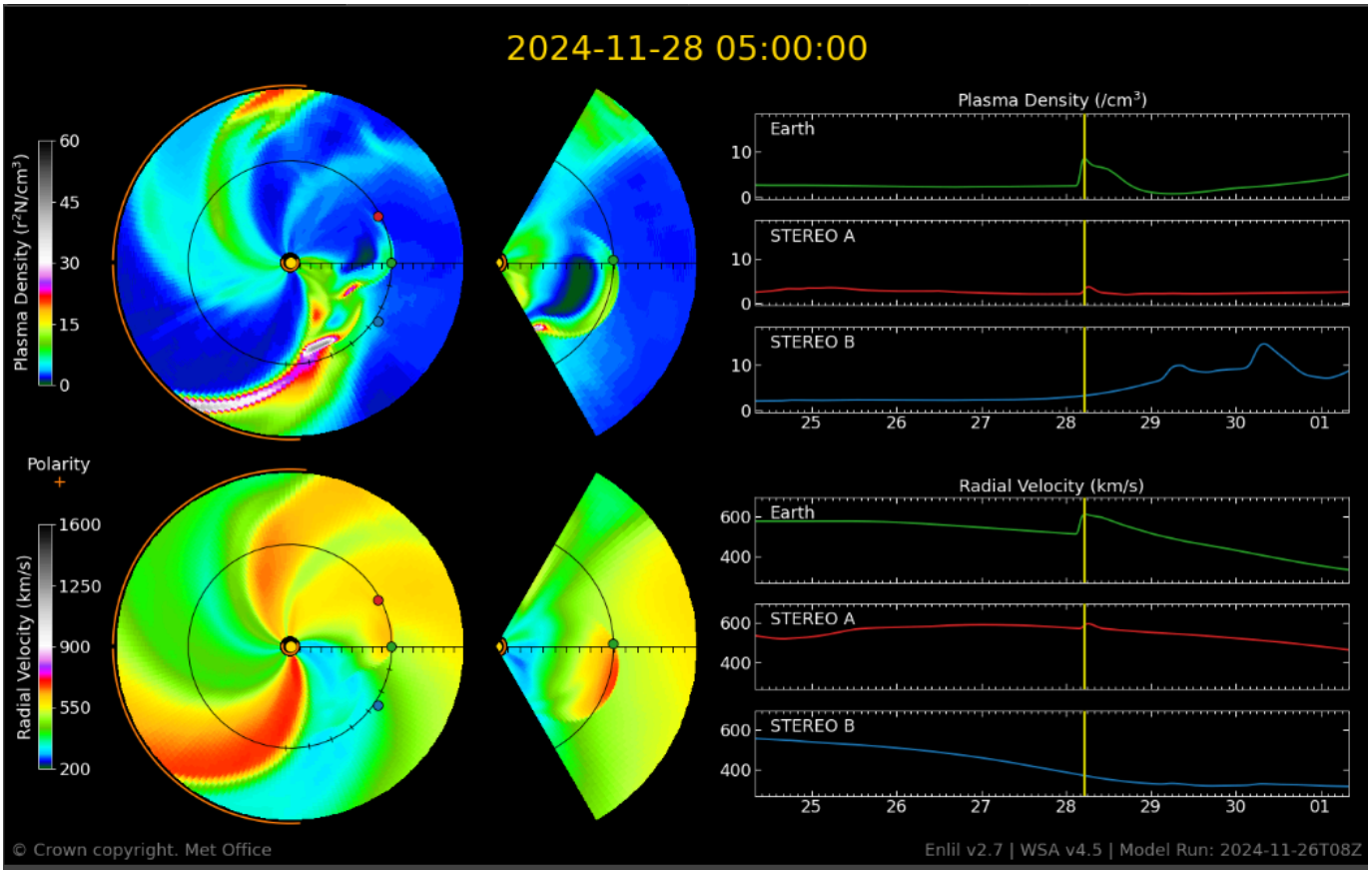

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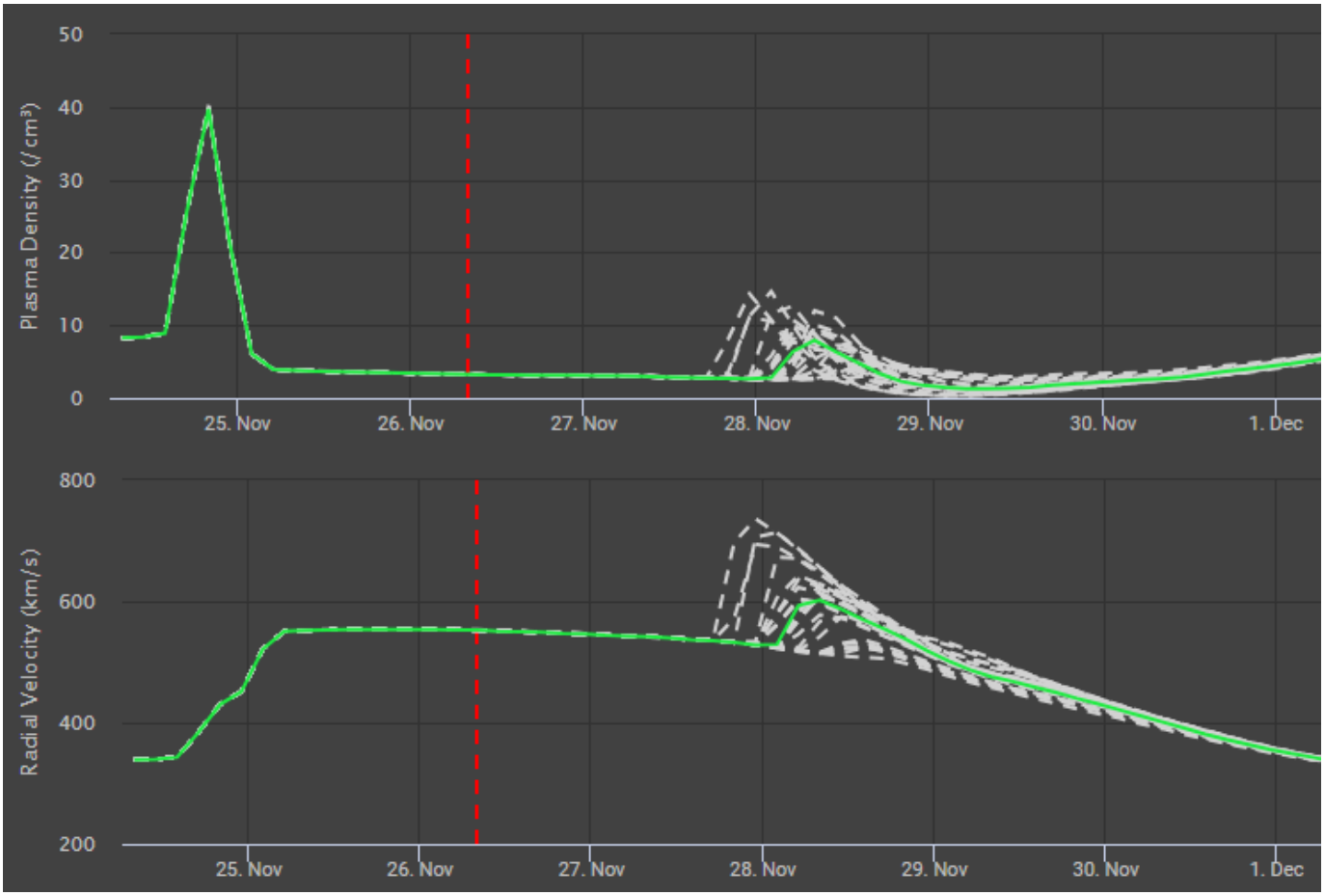
Figure 3: MOSWOC Ensemble model, showing spread of expected CME arrival times.



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Radio Blackouts - X-Ray Flares

There are currently ten active regions on the visible disc. The largest and most complex regions on the visible disc are located in the southeast quadrant (AR3905 and AR3906) and are in close proximity to each other. Both AR3905 and AR3906 contain moderately-large lead and trailing spots with both containing a small delta configuration, AR3905 on its leading spot and AR3906 near its main trailing spot. In general the intermediate spots are tending to decay and separate, especially in the case of AR3905, whilst AR3906 has seen its leading spot begin to fragment. AR3907 near centre-disc in the southwest has seen its trailing spots consolidating into a larger region of mixed polarity, indicating that a small delta configuration has formed. The region in the far northeast (Ex-AR3879) has now been numbered AR3910, and appears to contain a large, mature spot, with smaller spots surrounding it. It may yet reveal further complexity as it rotates into clearer view on the disc. The remaining groups on the disc are smaller and more magnetically simple.

Moderate solar activity has been observed in the last 24 hours with a number of M-class flares, peaking with an M2.0 flare at 25/1212 UTC from AR3906 in the southeast. Moderate to Moderate to High activity is forecast with occasional M-flares likely, primarily from AR3905, AR3906, or AR3910, along with a slight chance of an isolated X-class flare.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	70	70	70	70
Very Active	R3-R5 (X Class)	No	15	15	15	15

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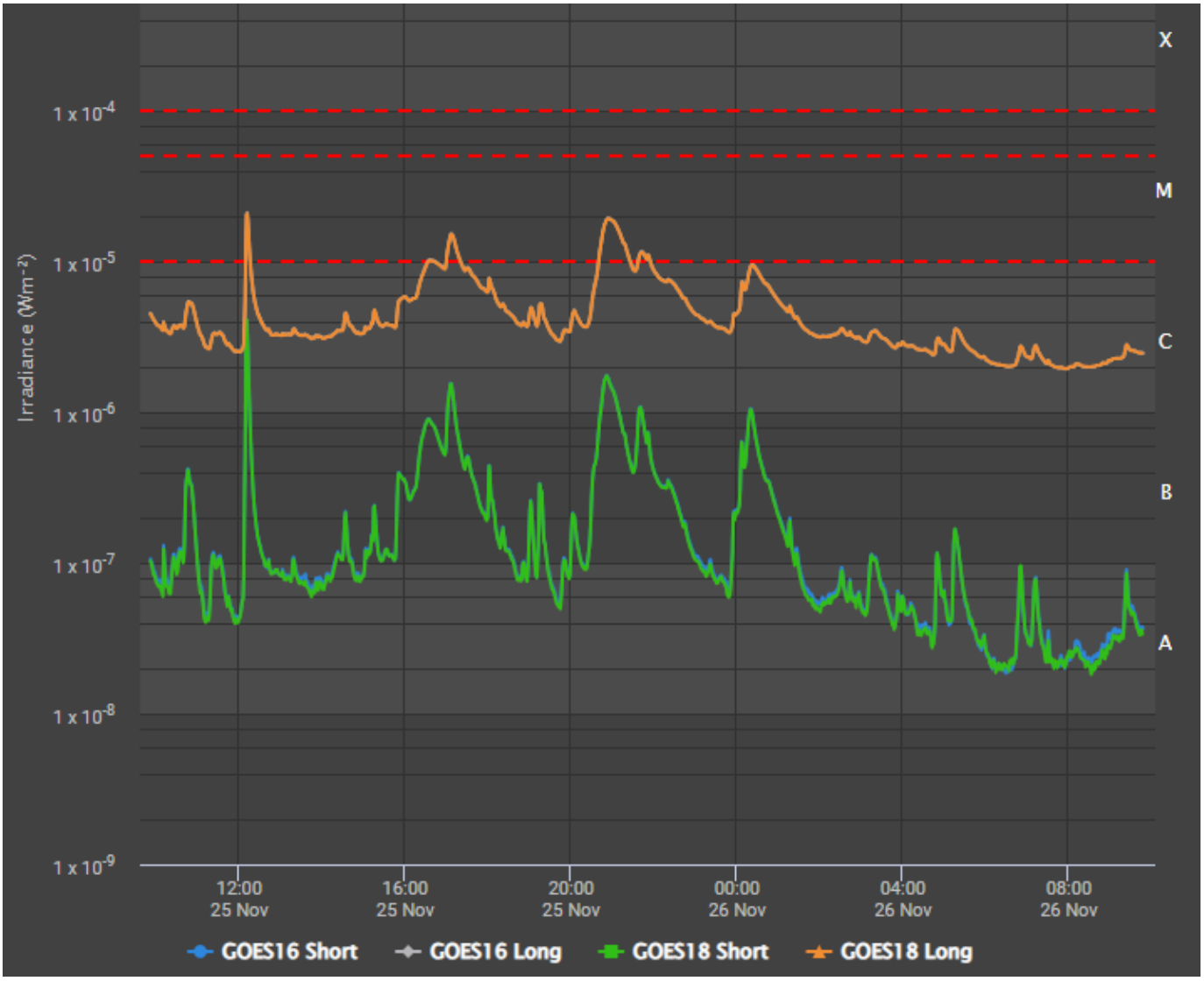
Figure 4: GOES-16 & -18 X-ray flux.



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Solar Radiation Storms (High Energy Protons)

GOES-18 Proton flux is at Background levels. The main regions currently on the visible disc which are most likely to produce proton enhancements are AR3905 and AR3906, both located in the southeast quadrant. From this position on the disc any proton enhancements are less likely to significantly affect Earth, but as they rotate towards and then beyond centre disc in the coming days that risk increases marginally. Subsequently, observed proton flux is expected to persist at Background levels, with a slight but increasing chance of Solar Radiation storms occurring later in the period.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

Electron flux observed by GOES-16 has been at Background levels and is expected to persist at these levels throughout the period. Some diurnal increases to moderate flux are possible through Days 1-2, but electron flux likely to become supressed later in the period following expected CME arrival on 28 Nov.

Associated 24 hour fluence is expected to persist below the Active threshold, perhaps with a slight rising trend in the coming days. MOSWOC REFM output thought to be providing reasonable guidance at first, with the indicated rise now thought to be unlikely with the expected CME arrival.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ 1×10^{8}**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ 1×10^{9}**	No	1	1	1	1

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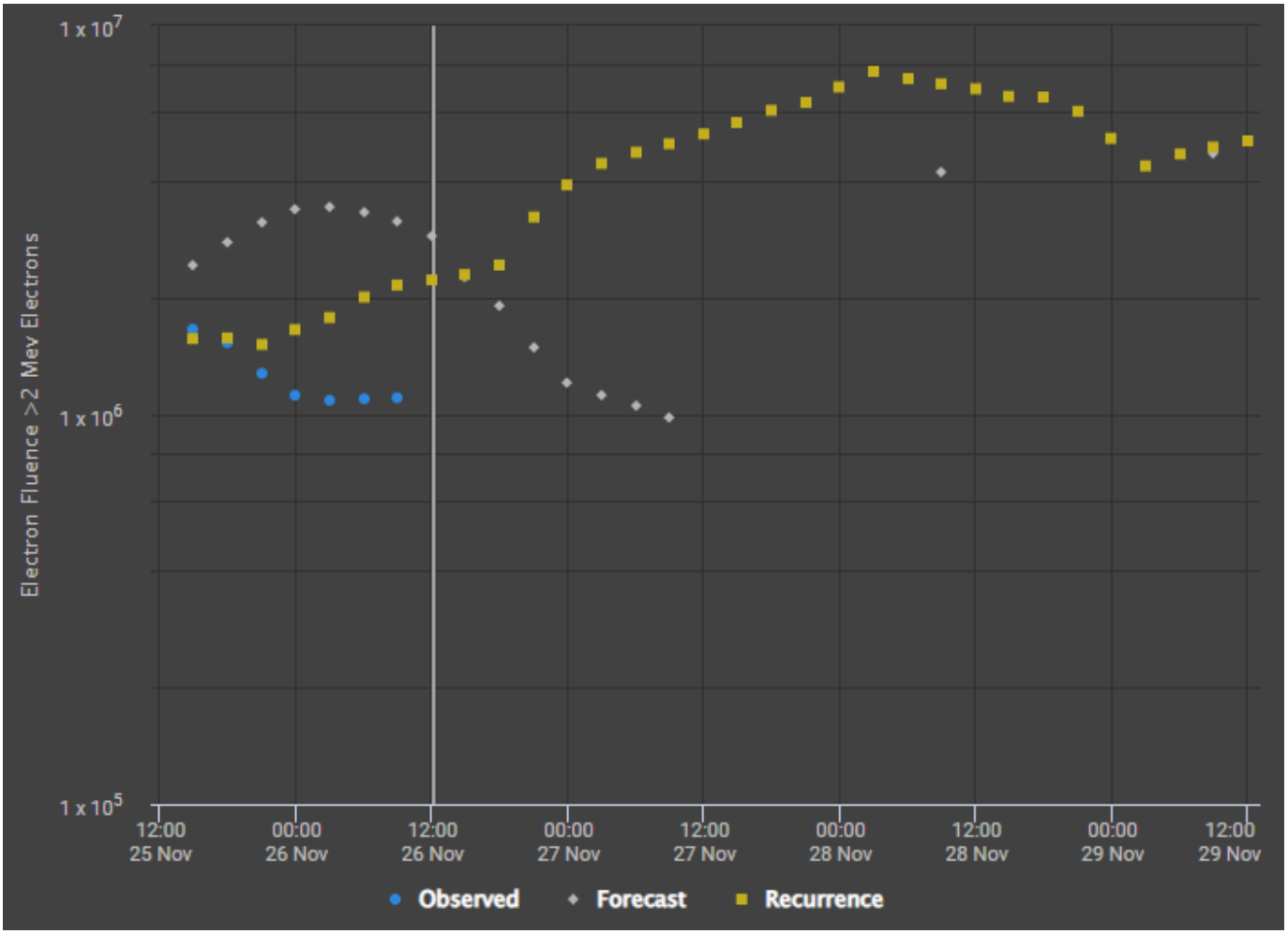
Figure 5: MOSWOC REFM



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